

MULTIMEDIA



UNIVERSITY

STUDENT ID NO

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MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2022/2023 (TERM ID 2210)

TIT3131 – INFORMATION THEORY

(All sections / Groups)

11 FEBRUARY 2023

9.00 am – 11.00 am

(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 7 pages with **Four** questions only.
2. Attempt **All** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please print all your answers in the Answer Booklet provided.

QUESTION 1

Question 1 contains **10 MCQ** questions, please choose the best answer and write it clearly in the answer booklet.

- (a) Which of the following statement is **FALSE**? [1 mark]
- [A] Entropy is a measure of uncertainty.
 - [B] The amount of information, $I(S_k)$ is related to the inverse of the probability of occurrence.
 - [C] Huffman coding represents high order relationships.
 - [D] None of above.
- (b) From the encoding **Table 1** below, decode the following codeword. "1100101101111". [1 mark]

Table 1

Symbol	Code
A	0
B	10
C	110
L	1110
E	1111

- [A] "LABEL"
 - [B] "CABCE"
 - [C] "CABLE"
 - [D] None of above.
- (c) Which of the following statement is **TRUE**? [1 mark]
- [A] Block codes in which message bits are transmitted in altered form are called systematic codes.
 - [B] Block codes in which message bits are transmitted in unaltered form are called non-systematic code.
 - [C] A cyclic code is not a linear block code.
 - [D] None of above.

- (d) Given an DMS, $S = \{A, B, C, D\}$ and the probability of occurrence for these symbols are showed in the **Table 2**. Calculate the probability of symbol "B" and information gained for symbol B. [1 mark]

Table 2

S_k	A	B	C	D
p_k	0.1	$2x$	$5x$	$2x$
$I(S_k)$				

- [A] $p_B = 0.01$ and $I(S_A) = 3.3219$ bit/symbol
 [B] $p_B = 0.1$ and $I(S_B) = 2.3219$ bit/symbol
 [C] $p_B = 0.2$ and $I(S_B) = 1.3219$ bit/symbol
 [D] None of above.
- (e) _____ is more when uncertainty is more. [1 mark]
- [A] Information.
 [B] Entropy.
 [C] Source coding.
 [D] Channel coding.
- (f) Given a code C which is defined as $C = \{c_1 = 10000, c_2 = 11101, c_3 = 00101, c_4 = 11001\}$. Then C is not linear. [1 mark]
- [A] TRUE.
 [B] FALSE.
- (g) Entropy is directly proportional to the uncertainty. [1 mark]
- [A] TRUE.
 [B] FALSE.
- (h) From the **Table 3** below, given that the Code I satisfies *Kraft inequality* and it is a prefix code, illustrate the meaning of "*Unique decodable*" by estimating a suitable code x . [1 mark]

Table 3

Symbol	Code 1
A	00
B	01
C	x
D	11

- [A] $x = 000$.
 [B] $x = 011$.
 [C] $x = 10$.
 [D] None of above.

- (i) Consider that a 100 kbps data stream is to be transmitted on a voice-grade telephone line with a bandwidth of 3 kHz with signal-to-noise of 10 dB. The Channel capacity $C = 10378.2949$ bit/sec. [1 mark]

[A] TRUE
[B] FALSE

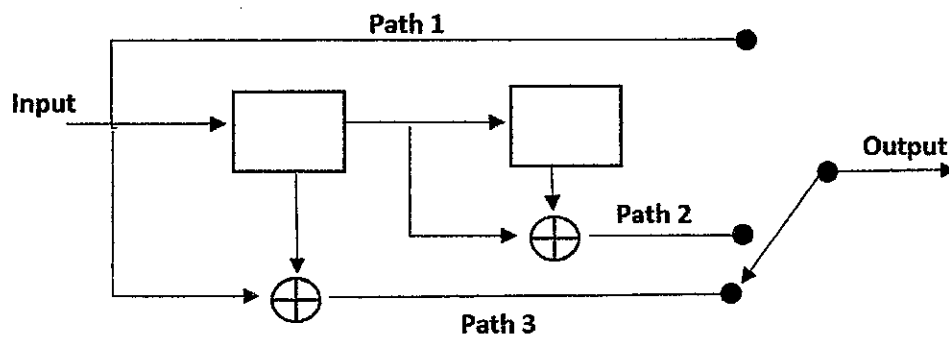
- (j) Consider a generator matrix (6, 3) linear block code below. The generator matrix is expressed in systematic form. [1 mark]

$$G = \begin{bmatrix} 0 & 1 & 1 & 1 & 0 & 0 \\ 1 & 1 & 1 & 0 & 1 & 0 \\ 1 & 1 & 0 & 1 & 0 & 1 \end{bmatrix}$$

[A] TRUE
[B] FALSE

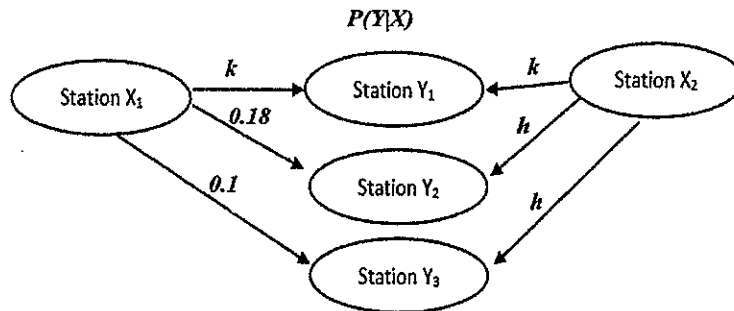
QUESTION 2

- (a) Consider the following source with discrete memoryless source with source alphabet $S = \{S_0, S_1, S_2\}$ with $p_0 = 0.6$, $p_1 = 0.2$, $p_2 = 0.2$. Prove that $H(S^3) = 3 H(S)$. [3 marks]
- (b) Construct the encoder circuit for the generator polynomial for a $(6, 3)$ cyclic code generated by $g(D) = 1 + D + D^3$. [4 marks]
- (c) Given convolutional code of path 1, path 2 and path 3 in Figure 1. Find g_1 , g_2 and g_3 . [3 marks]

**Figure 1****Continued...**

QUESTION 3

- (a) A source X produces letters from a two symbol alphabet with the probability assignment $P(X_1) = 0.3$ and $P(X_2) = 0.7$. Each source letter X is transmitted through a channel from a source X to the destination Y as shown in **Figure 2**. The transition probabilities are indicated as below.

**Figure 2**

- i. From **Figure 2**, what is the value of k and h ? Prepare the conditional probability $P(Y|X)$ and joint probability tables $P(Y,X)$. [3 marks]
 - ii. Write all the steps to show that $I(Y,X)$ is equal to $I(X,Y)$. [3 marks]
- (b) Complete the **Table 4** and construct a state diagram given a convolutional path of $g_1[1,1,1]$ and $g_2[1,1,0]$. [4 marks]

Table 4

m_0 Input	m_1	m_2	g_1	g_2	Current State	Next State
0	0	0				
1	0	0				
0	1	0				
1	1	0				
0	0	1				
1	0	1				
0	1	1				
1	1	1				

QUESTION 4

- (a) Consider the generator polynomial for a (6,3) cyclic code generated by $g(D) = 1 + D + D^3$. Construct the generator matrix, in "systematic" form.
[3 marks]
- (b) Consider the generator polynomial for a (6,3) cyclic code generated by $g(D) = 1 + D + D^3$. Construct all the valid code words for the following messages in "non-systematic" form. Show your steps.
[3 marks]

Message	$m(D)$	$c(D)$	Code word
111			
110			
100			

- (c) Consider the generator polynomial for a (6,3) cyclic code generated by $g(D) = 1 + D + D^3$. Construct the valid code words for the following messages in "systematic" form. Show your steps.
[4 marks]

Message	$m(D)$	$c(D)$	Code word
001			
010			
011			
101			

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